

In the Specification:

Column 1, delete the paragraph between lines 31-38 and replace with:

--However, a mouse, requires a relatively large and flat 2-dimensional surface on which to move. Typically, this surface must be unobstructed and dedicated to mouse movement and measure over 9"x9".--~~As~~ as a result. Other controllers, such as the trackball and joystick, are often used when flat surfaces are unavailable, as in the case of portable computers. However, trackballs and joysticks are constrained to use on a surface of practical applications.--

Column 1, delete the paragraph between lines 39-64 and replace with:

--Further, trackballs, joysticks, keys and mice are not mobile in free space nor do they provide three-dimensional output. One controller which is mobil in space is taught by Ronald E. Milner in this U.S. Pat. No. 4,682,152. "Sonic Positioning Device," issued Jan. 25, 1990. This device senses the position of a controller device in three dimensions by sensing the position of an ultrasonic transmitter relative to an array of receivers. However, this device is not a true pointing device as it senses position rather than a vector from the device. Since the controller must be repositioned in space, rather than simply reoriented, relatively large hand movements are required to define cursor movements. Another controller ~~mobil~~ mobile in free space, the Mattel Power Glove video game

controller, incorporates two ultrasonic transmitters in a single controller and thus can determine a position ~~as well as~~ and define a “pointing” vector through the two transmitters. However, both of these ultrasonic controllers are based on ranging techniques and thus have range and resolution limitations. Specifically, both must be used in conjunction with an array of receivers to determine the exact position of the controllers. This results in reduced accuracy as the controller is moved to a position more distant from the receivers. Further, these controllers are only ~~use~~ able usable in an active volume of space defined by those receivers. Further still, both are limited to use in relatively noise-free environments.--

Column 2, delete the paragraph between lines 18-30 and replace with:

--Accordingly, it is desirable to provide a hand-held computer control device which has a long range and high resolution. Further, the controller should not be constrained to use on a flat surface or within a confined space. Further, it is desirable to have a controller which responds to a vector defined by the controller, i.e., responds to “pointing” of the controller, as opposed to merely detecting the position of the controller. It is desirable to have a controller which is self-contained and not subject to interference ~~form~~ from outside sources of noise or subject to reduced accuracy as it is moved distant from an array of receivers.

Further, it is desirable to provide a controller that produces three-dimensional output.--

Column 4, delete the paragraph between lines 30-56 and replace with:

--Cabling 180 transmits power from an ~~interlace~~ interface box 185 to outer housing 175 and returns data signals from shaft angle encoder sensing optics 165. In the preferred embodiment interface box 185 translates signals from the optical sensing system 165 into serial data for an RS-232 port. Wall adapter 190 provides D.C. power for motor 105 and ~~shaft~~ shaft angle encoder sensing optics 165.

The construction details of the inner and outer gimbals is are shown in further detail in FIG. 2. FIG. 2 is an expanded perspective view of inner gimbal 115 and bearing 122. Inner gimbal 115 includes a circular plug 205 which fits within the inner race of bearing 122. A conductive pin 210, having a diameter smaller than that of plug 205, is mounted concentrically with plug 205 and electrically coupled to motor 205. Pin 210 is preferably made of a low-friction conductive material such as carbon-teflon and designed to protrude from the inner race of bearing 122. The diameter of pin 210 is smaller than the diameter of the inner race so as not to contact the inner race and to minimize the friction of the rotating contact. A stainless steel spring 215 is mounted to gimbal frame 135 and aligned with and in electrical contact with protruding surface 220 of pin 210.

Spring 215 is electrically coupled to a D.C. power source through outer gimbal 140. Spring 215 presses against pin 210 providing a low friction electrical connection between gimbal frame 135 and inner module 110. Inner gimbal 120 and outer gimbals 140 and 145 are constructed in an identical manner.--

Column 5, delete the paragraph between lines 10-20 and replace with:

--~~And~~ A second optical pattern is machined into gimbal frame 135 along a cylindrical section 170 of gimbal frame 135. This pattern interacts with ~~shaft~~ shaft angle encoder sensing optics 165 for sensing rotation of gimbal frame 135 around its axis of rotation through gimbals 140 and 145. This cylindrical section is geometrically centered about the axis of rotation of gimbal frame 135, which passes through gimbals 140 and 145. As with the optical pattern on the inner module 110, the optical pattern on gimbal frame 135 is constructed by applying reflective paint to cylindrical section 170 and then machining grooves of 0.015 inch depth and width on the surface of the cylinder.--

Column 5, delete the paragraph between lines 31-67 and replace with:

--Shaft angle encoder sensing optics 165 interact with the optical pattern on inner module 110 so as to determine the rotation of the inner module 110 about its axis of rotation. More specifically, shaft angle encoder sensing optic 165 include

sources for illuminating the patterns, lenses for focusing images of the patterns, and photodetectors for ~~detect a~~ detecting dark or light areas. Referring to FIG. 3, a first LED 305 is mounted to shock frame 160 at an angle of 30 degrees from vertical in a plane parallel to the axis through gimbals 140 and 145 so as to floodlight an area 310 of the optical pattern on inner module 110. This area is centered on the "equator" of frame 135 so as to provide maximum range of detectable movement in both directions. Lens 315 and mirror 320 focus and reflect the image of the illuminated optical pattern onto quad photodiode 325. Lens 315 is an injection molded lens of approximately 1/8 inch in diameter having a focal length of approximately 0.2 inches.

Quad photodiode 325 comprises four photodiodes, 402, 404, 406 and 408, located in a row as illustrated in FIG. 4. The sides of quad photodiode 325 are aligned with the edges of the projected image of the optical pattern on inner module 110. One period of the projected image of the optical pattern on inner module 110 (one light and one dark bar) nominally covers the quad photodiode 325, which comprise four photodiodes centered 0.02 inches apart. Photodiodes 402 and 406 are ~~counted~~ coupled to comparator 420 ~~410~~. Photodiodes 404 and 408 are coupled to comparator ~~410~~ 420. The output V1 of comparator 410 is thus in phase quadrature with the output V2 of comparator 420. These outputs are then detected by conventional means to determine the rotation of the inner module. An

example of phase quadrature resolution is provided in U.S. Pat. No. 4,346,989 titled Surveying Instrument, issued to Alfred F. ~~Gori~~ Gort and Charles E. Moore August 31, 1982 and assigned to the Hewlett-Packard Company. A prototype of this embodiment of the present invention results in a resolution of approximately 100 counts per inch.--

Column 6, delete the paragraphs between lines 18-57 and replace with:

Quad photodiode 345 comprises four photodiodes located in a row and is identical in construction to quad photodiode 325 illustrated in FIG. 4. The sides of quad photodiode 345 are aligned with the edges of the projected image of the optical pattern on gimbal frame 135. FIG. 5 is an illustration of the preferred embodiment of a gyroscopic pointing device 500 coupled to a computer 502 and computer display 505. Computer 502 is adapted so that changing the pitch of controller 500 relative to the gravity vector ~~charges~~ changes the vertical position of cursor 510 on computer display 505. That is, rotating the controller forward (“pitch”) causes the cursor to drop on a vertical computer screen, rotating it back causes the cursor to drop on a vertical computer screen, rotating it back causes the cursor to rise, as if the controller was pointing at the cursor. Similarly, rotating the controller from side to side (“roll”) changes the horizontal position of cursor 510 on computer display 505. That is, rotating the controller left causes the cursor to

move left on a vertical computer screen, rotating it right causes the cursor to move to the right, again, as it if the controller was pointing at the cursor. Controller 500 further includes a thumb operated push button 520 and has a rounded hemispherically shaped bottom portion 525 adapted for smoothly rocking on a flat surface when the pitch and roll of controller 500 is varied while resting on a flat surface. This can be a two position switch, where initial pressure on the switch activates the controller and causes the cursor to move in response to the controller, and a second position of the switch results in a "pick" or "select" signal being transmitted to the computer.

FIG. 6 is a top view of an alternative embodiment of the present invention. FIG. 7 is a top perspective view of the same embodiment. Specifically, FIGS. 6 and 7 illustrate a controller shaped so as to be hand held in a manner such that the palm will be facing down while controller 610 is resting on a flat surface. The under side of controller 610 is rounded to facilitate changes of its orientation with respect to vertical. A palm button 620 is actuated when the controller is grasped, thus permitting the controller to be deactivated, moved or reoriented, then reactivated. A pick button 630 is located for selective activation by a ~~users fingers~~ user's fingers in a manner similar to the use of a pick button on a mouse controller.--

Column 7, delete the paragraph between lines 13-34 and replace with:

--While the invention has been particularly taught and described with reference to the preferred embodiment, those versed in the art ~~will~~ will appreciate that minor modifications in form and detail may be made without departing from the spirit and scope of the invention. For instance, although the illustrated embodiment teaches one system of shaft angle encoders, many alternative systems could be used for detecting the orientation of the gyroscopic controller. Further, while the preferred embodiment ~~teaches~~ teaches a vertically oriented gyroscope and detection of two angles from vertical such as in an artificial horizon instrument. Other gyroscopic orientations, such as those used for directional gyroscopes, could be substituted. Further, while the present invention teaches the detection of two angles from a vertically oriented gyroscope and one angle from a horizontally oriented gyroscope, two angles could be detected from the horizontal gyroscope, and one from the vertical gyroscope. Further, many techniques equivalent ~~techniques~~ to the pendulous technique are known for orienting gyroscopes. Accordingly, all such modifications are embodied within the scope of this patent as and properly come within ~~our~~ my contribution to the art ~~and as~~ as are particularly pointed out by the following claims.--